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CATASTROPHIC VOLCANISM AS A CAUSE OF SHOCKED FEATURES FOUND AT THE K/T BOUNDARY AND IN CRYPTOEXPLOSION STRUCTURES;

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The presence of quartz grains containing shock lamellae at the K/T boundary is viewed by many as the single most compelling evidence of meteoritic or cometary impact because there is no known endogenous mechanism for producing these features. Similarly the presence of shocked quartz, shatter cones, coesite and stishovite at cryptoexplosion structures is commonly taken as conclusive evidence of impact. However, several recent studies have cast doubt on this interpretation. Carter *et al.* (1,2) found stress features in quartz grains from Toba, Sumatra and Long Valley Calderas, which are known to be the result of silicic volcanic eruptions. Also Rice (3) has argued that the Mt. St. Helens eruption was associated with an overpressure as high as 1000 kbar.

We shall argue that basaltic volcanism , although not normally explosive, can under exceptional circumstances produce overpressures sufficiently high to produce shock features. The exceptional circumstances include a high content of volatiles, usually CO_2, and no pre-established pathway to the surface. These circumstances would arise, for example, as hot primitive material from the deep mantle establishes a plume (4). As a volatile-laden magma rises to the surface through the cold lithosphere, cooling and partial crystallization will cause the remaining melt to become saturated in volatiles (5). If these volatiles were to exsolve rapidly, they could produce a high overpressure; see figure 10-12 of Yoder (6). This could be achieved by cooling the magma rapidly.

Rapid cooling of the saturated basaltic magma can occur if it underlies a cooler more evolved magma in a chamber (7,8). Initial slow cooling and partial exsolution of the volatiles will cause the density of the basaltic magma to become less than that of the overlying magma, leading to overturning and mixing. The mixing cools the basaltic magma rapidly with an associated massive exsolution of volatiles and buildup of pressure. Evidence from kimberlites and diamonds (9,10) indicates that CO_2 can exsolve at pressures of at lease 80 kbar. By comparison the yield stress of quartz is from 3 to 20 kbar, depending on pressure.

The gas will escape the magma chamber along planar cracks once the pressure becomes sufficiently high. It is well known that pressurized fluids, especially gases, greatly facilitate fracturing (11). In the vicinity of

the crack tip there is a smallscale deviatoric stress pattern which we argue is sufficiently high to produce transient cracks along secondary axes in the quartz crystals, causing the planar features. The CO_2-rich fluid inclusions which have been found along planar elements of quartz in basement rocks of the Vredefort Dome (12,13) were likely to have been emplaced by such a process.

If the mechanism described here is capable of producing shocked features such as shattercones, quartz lamellae, coesite and stishovite, it would require a reassessment of the origin of many cryptoexplosion structures as well as seriously weakening the case for an impact origin of the K/T event.

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